Claims

main claim to flow-mixing-channels on a radially-inwards-flow, outside-fed die

Claim 1. Extrusion die apparatus, for manufacturing blown plastic film, wherein:

the apparatus includes a die-member;

the die-member is of generally annular form, having a circumferentially-disposed outer-face and inner-face;

the die-member has a groove-face-A, which is of annular configuration, and which has an inner-edge-A;

the groove-face-A is formed with melt-conveying-channels-A;

the die-member includes a melt-entry-port, which is located in the outer-face of the die-member;

the apparatus includes an annular groove-opposing-surface-A;

the melt-conveying-channels-A include N spiral-grooves-A, which are open, and are formed into the groove-face-A;

the apparatus is so arranged that melt, in flowing towards the inner-edge-A, spills over lands between turns of the spiral-grooves-A;

the melt-conveying-channels-A are arranged, in relation to the groove-opposing-surface-A, for conveying liquid melt under pressure from the melt-entry-port in the outer-face, in a progressively inwards sense, through the spiral-grooves-A, to the inner-edge-A of the groove-face-A;

the melt-conveying-channels-A include at least N supply-channels-A;

the melt-conveying-channels-A include flow-divider-channels-A, which receive melt from the melt-entry-port, and divide the same into at least N incoming-streams, and convey the incoming-streams one each into the supply-channels-A respectively;

the melt-conveying-channels-A include flow-mixing-channels-A;

the flow-mixing-channels-A include subdivider-junctions-A and recombiner-junctions-A;

at the subdivider-junctions-A, respective ones of the at least N incoming-streams from the supply-channels-A are sub-divided into respective left and right subdivided-streams;

the recombiner-junctions are positioned inwards of the subdivider-junctions, and between adjacent subdivider-junctions, in the sense of being positioned to receive the subdivided-streams moving inwards from the adjacent subdivider-junctions;

the melt-conveying-channels are so configured that, in respect of each one of the recombiner-junctions, the recombiner-junction receives the left subdivided-stream from the adjacent one of the subdivider-junctions to the right of that recombiner-junction, and receives the right subdivided-stream from the adjacent one of the subdivider-junctions to the left of that recombiner-junction, and combines the said left and right subdivided-streams into one recombined-stream respective to that recombiner-junction;

the melt-conveying-channels-A include N of the recombiner-junctions, and the arrangement of the melt-conveying-channels is such that the N recombined-streams flow inwards, one each respectively, to the N spiral-grooves-A;

and the melt-conveying-channels-A are so arranged as to convey melt from the melt-entry-port in the outer-face inwards first through the flow-divider-channels, then inwards through the supply-channels-A, then inwards through the flow-mixing-channels-A, then inwards through the spiral-grooves-A, then inwards towards the inner-edge-A of the groove-face-A.

claims to single sided

Claim 2. Apparatus of claim 1, wherein N = a number in the series 2,4,8,16...

Claim 3. Apparatus of claim 2, wherein N = 4.

Claim 4. Apparatus of claim 1, wherein the groove-opposing-surface-A is a smooth flat plane, the groove-face-A being correspondingly flat.

Claim 5. Apparatus of claim 1, wherein the groove-opposing-surface-A

is a concave frustum of a right cone, the groove-face-A being correspondingly convexly conical.

Claim 6. Apparatus of claim 1, wherein the flow-divider-channels-A and the flow-mixing-channels-A comprise open grooves, which are formed into the groove-face-A.

Claim 7. Apparatus of claim 1, wherein:

the arrangement of the apparatus is such that the spiral-grooves receive liquid-melt that has passed from the melt-entry-port along respective pathways within the melt-conveying-channels-A;

the respective pathways are of equal length, and of equal number of divisions and confluences, and of equal tortuousnesses.

lands between grooves.

Claim 8. Apparatus of claim 1, wherein:

the N spiral-grooves-A include spiral-groove-F and spiral-groove-G, spiral-groove-G being the next-adjacent spiral-groove to the right of spiral-groove-F;

start-groove-F is the respective start-channel-A to spiral-groove-F;

start-groove-G is the respective start-channel-A to spiral-groove-G, whereby start-groove-G lies to the right of start-groove-F;

supply/feed-junction-FG is the respective supply/feed-junction located between the start-channel-F and the start-channel-G;

feed-groove-FG-F is the respective feed-channel that runs leftwards from the supply/feed-junction-FG to the start-groove-F;

feed-groove-FG-G is the respective feed-channel that runs rightwards from the supply/feed-junction-FG to the start-groove-G;

base-land-FG is the area bounded by and between the following grooves: spiral-groove-F; start-groove-F and start-groove-G; feed-groove-FG-F and feed-groove-FG-G;

radial lines drawn on the annular groove-face-A, at a spiral-orientation relative to the datum-point, pass through both the spiral-groove-F and the spiral-groove-G, and through a spiral-land-FG therebetween;

radial lines drawn on the annular groove-face-A, at a base-orientation relative to the datum, pass through spiral-groove-F, and do not pass through spiral-groove-G, and do pass through base-land-FG;

the spiral-land-FG is of such height as to be clear of groove-opposing-surface-A, and to be so clear thereof that melt leaks and spills over the spiral-land-FG, out of spiral-groove-G, and inwards towards the inner-edge-A of the die-member;

the base-land-FG is of such height as to be tight against the groove-opposing-surface-A, whereby substantially no leakage or spillage of melt occurs over the base-land-FG;

the groove-face-A is formed with a step-FG, and the step-FG marks the change in height between the base-land-FG and the spiral-land-FG, in that the base-land-FG lies to the left, and the spiral-land-FG lies to the right, of the step-FG.

Claim 9 Apparatus of claim 8, wherein the change in height between the base-land-FG and the spiral-land-FG, at the step-FG, is at least one millimetre.

Claim 10. Apparatus of claim 8, wherein the step-FG is located adjacent to start-groove-G, in that:

the step-FG marks a first portion of a right-side-boundary of the base-land-FG;

the start-groove-G has a left edge and a right edge;

the edges of the start-groove-G lie approximately radially with respect to the annular groove-face-A;

the left edge of start-groove-G marks a second portion of the right-side-boundary of the base-land-FG;

the said first portion of the right-side-boundary of the base-land-FG is at least approximately contiguous with the said second portion.

Claim 11. Apparatus of claim 10, wherein the step-FG follows a line that lies, at least approximately, on a radius of the annular groove-face-A.

claims to grooves on both sides of die-member

Claim 12. Apparatus of claim 1, wherein the annular die-member has grooves both sides, in that:

the die-member also has a groove-face-B, on the opposite thereof from groove-face-A;

the groove-face-B is of annular configuration, and has an inner-edge-B;

the groove-face-B is formed with melt-conveying-channels-B;

the melt-conveying-channels-B include M spiral-grooves-B, which are open, and are formed into the groove-face-B;

the melt-conveying-channels-B are arranged for conveying liquid melt under pressure from the melt-entry-port in the outer-face, in a progressively inwards sense, through the spiral-grooves-B, to the inner-edge-B of the groove-face-B;

the melt-conveying-channels-A include at least M supply-channels-A;

the melt-conveying-channels-B include flow-divider-channels-B, which receive melt from the melt-entry-port, and divide the same into at least M incoming-streams, and convey the incoming-streams one each into the supplu-channels-A respectively;

the melt-conveying-channels-B include flow-mixing-channels-B;

the flow-mixing-channels-B include subdivider-junctions-B and recombiner-junctions-B;

at the subdivider-junctions-B, respective ones of the at least M incoming-streams from the flow-divider-channels-B are sub-divided into respective left and right subdivided-streams;

the recombiner-junctions are positioned inwards of the subdivider-junctions, and between adjacent subdivider-junctions, in the sense of being positioned to receive the subdivided-streams moving inwards from the adjacent subdivider-junctions;

the melt-conveying-channels are so configured that, in respect of each one of the recombiner-junctions, the recombiner-junction receives the left subdivided-stream from the adjacent one of the subdivider-junctions to the right of that recombiner-junction, and receives the right subdivided-stream from the adjacent one of the subdivider-junctions to the left of that recombiner-

junction, and combines the said left and right subdivided-streams into one recombined-stream respective to that recombiner-junction;

the melt-conveying-channels-B include M of the recombiner-junctions, and the arrangement of the melt-conveying-channels is such that the M recombined-streams flow inwards, one each respectively, to the M spiral-grooves-B;

and the melt-conveying-channels-B are so arranged as to convey melt from the melt-entry-port in the outer-face inwards first through the flow-divider-channels, then inwards trhough the supply-channels-B, then inwards through the flow-mixing-channels-B, then inwards through the spiral-grooves-B, then inwards towards the inner-edge-B of the groove-face-B.

grooves in sides A and B are both clockwise

Claim 13. Apparatus of claim 12, wherein:

the N spiral-grooves-A have a spiral-sense that is clockwise when viewed from one side of the annular die-member;

the M spiral-grooves-B have a spiral-sense that is also clockwise, when viewed from that same one side of the die-member.

sides A and B have separate melt-entry-channels

Claim 14. Apparatus of claim 12, wherein:

the melt-conveying-channels-A include an entry-channel-A, which is in melt-conveying communication with, and receives melt from, the melt-entry-port;

the entry-channel-A is in melt-conveying communication with N flow-divider-channels-A, which are so arranged as to split the flow from the melt-entry-port equally therebetween;

the N flow-divider-channels are in melt-conveying communication respectively with the N supply-channels-A;

the melt-conveying-channels-A are so arranged as to convey melt from the melt-entry-port to the entry-channel-A, then progressively inwards to the flow-divider-channels-A, and then inwards to the supply-channels-A.

melt entry channels are staggered

Claim 15. Apparatus of claim 14, wherein:

the die-member includes a melt-entry-channel-A, and the melt, in passing from the melt-entry-port in the outer-face to the melt-conveying-channels-A, passes inwards through the melt-entry-channel-A;

the die-member includes a melt-entry-channel-B, and the melt, in passing from the melt-entry-port in the outer-face to the melt-conveying-channels-B, passes inwards through the melt-entry-channel-B;

the arrangement of the apparatus is such that all melt entering the set of melt-conveying-channels-A is melt that has passed through melt-entry-channel-A, and all melt entering the set of melt-conveying-channels-B is melt that has passed through melt-entry-channel-B;

the die-member includes a channel/groove-junction-A, at which melt from the melt-entry-channel-A transfers into the set of melt-conveying-channels-A;

the die-member includes a channel/groove-junction-B, at which melt from the melt-entry-channel-B transfers into the set of melt-conveying-channels-B;

with respect to a datum-point on the outer-face of the die-member, channel/groove-junction-A lies orientated at an orientation-angle-A thereto, and channel/groove-junction-B lies orientated at an orientation-angle-B thereto;

and the channel/groove-junction-A is staggered, circumferentially, with respect to channel/groove-junction-B, in that orientation-angle-A is different from orientation-angle-B.

Claim 16. Apparatus of claim 15, wherein the melt-conveying-channels-A are correspondingly offset circumferentially, relative to the datum-point, from the melt-conveying-channels-B.

Claim 17. Apparatus of claim 15, wherein:

the melt-entry-port includes one pipe-connector, whereby the melt-

entry-port can be connected by a pipe to a source of pressurised hot melt;

and both melt-entry-channel-A and melt-entry-channel-B are in melt-conveying communication with the one pipe-connector.

Claim 18. Apparatus of claim 15, wherein:

the melt-entry-port includes pipe-connector-A and pipe-connector-B, whereby the melt-entry-port can be connected by pipes to sources of pressurised hot melt;

pipe-connector-A and pipe-connector-B are separate from each other, within the die-member;

melt-entry-channel-A is in melt-conveying communication with pipe-connector-A;

and melt-entry-channel-B is melt-conveying communication with pipe-connector-B.

independent claim to staggered ports, = radially-inwards-flow, outside-fed, die with grooves both sides, not depemdent on flow mixing channels

this claim is not supported by the gowlings spec

Claim 19. Extrusion die apparatus, for manufacturing blown plastic film, wherein:

the apparatus includes a die-member;

the die-member is of generally annular form, having a circumferentially-disposed outer-face and inner-face;

the die-member has opposing side faces, comprising annular groove-face-A and annular groove-face-B, respectively;

groove-face-A meets the inner-face at inner-edge-A, and groove-face-B meets the inner-face at inner-edge-B;

groove-face-A is formed with a set of melt-conveying-channels-A, and groove-face-B is formed with a set of melt-conveying-channels-B;

the die-member includes a melt-entry-port, which is located in the circumferential outer-face of the die-member;

the arrangement of the melt-conveying-channels-A is such that liquid

melt passes under pressure from the melt-entry-port, inwards through the set of melt-conveying-channels-A, and inwards to, and over, the inner-edge-A;

the arrangement of the melt-conveying-channel-B is such that liquid melt passes under pressure from the melt-entry-port, inwards through the set of melt-conveying-channels-B, and inwards to, and over, the inner-edge-B;

the die-member includes a melt-entry-channel-A, and the melt, in passing from the melt-entry-port in the outer-face to the set of melt-conveying-channels-A, passes inwards through the melt-entry-channel-A;

the die-member includes a melt-entry-channel-B, and the melt, in passing from the melt-entry-port in the outer-face to the set of melt-conveying-channels-B, passes inwards through the melt-entry-channel-B;

the arrangement of the apparatus is such that all melt entering the set of melt-conveying-channels-A is melt that has passed through melt-entry-channel-A, and all melt entering the set of melt-conveying-channels-B is melt that has passed through melt-entry-channel-B;

the die-member includes a channel/groove-junction-A, at which melt from the melt-entry-channel-A transfers into the set of melt-conveying-channels-A;

the die-member includes a channel/groove-junction-B, at which melt from the melt-entry-channel-B transfers into the set of melt-conveying-channels-B;

with respect to a datum-point on the outer-face of the die-member, channel/groove-junction-A lies orientated at an orientation-angle-A thereto, and channel/groove-junction-B lies orientated at an orientation-angle-B thereto;

and the channel/groove-junction-A is staggered, circumferentially, with respect to channel/groove-junction-B, in that orientation-angle-A is different from orientation-angle-B.

independent claim to both clockwise - not dependent on flow-mixing

channels

Claim 20. Extrusion die apparatus, for manufacturing blown plastic film, wherein:

the apparatus includes a die-member;

the die-member is of generally annular form, having a circumferentially-disposed outer-face and inner-face;

the die-member has opposing side faces, comprising annular groove-face-A and annular groove-face-B, respectively;

groove-face-A meets the inner-face at inner-edge-A, and groove-face-B meets the inner-face at inner-edge-B;

groove-face-A is formed with a set of melt-conveying-channels-A, and groove-face-B is formed with a set of melt-conveying-channels-B;

the die-member includes a melt-entry-port, which is located in the circumferential outer-face of the die-member;

the melt-conveying-channels-A include N spiral-grooves-A, which are open, and are formed into the groove-face-A;

the apparatus is so arranged that melt, in flowing towards the inner-edge-A, spills over lands between turns of the spiral-grooves-A;

the melt-conveying-channels-A are arranged for conveying liquid melt under pressure from the melt-entry-port in the outer-face, in a progressively inwards sense, through the spiral-grooves-A, to, and over, the inner-edge-A of the groove-face-A;

the melt-conveying-channels-B include M spiral-grooves-B, which are open, and are formed into the groove-face-B;

the apparatus is so arranged that melt, in flowing towards the inner-edge-B, spills over lands between turns of the spiral-grooves-B;

the melt-conveying-channels-B are arranged for conveying liquid melt under pressure from the melt-entry-port in the outer-face, in a progressively inwards sense, through the spiral-grooves-B, to, and over, the inner-edge-B of the groove-face-B;

the N spiral-grooves-A have a spiral-sense that is clockwise when viewed from one side of the annular die-member;

the M spiral-grooves-B have a spiral-sense that is also clockwise, when viewed from that same one side of the die-member.

indep claim to grooves in A being circumf offset from grooves in B

Claim 21. Extrusion die apparatus, for manufacturing blown plastic film, wherein:

the apparatus includes a die-member;

the die-member is of generally annular form, having a circumferentially-disposed outer-face and inner-face;

the die-member has opposing side faces, comprising annular groove-face-A and annular groove-face-B, respectively;

groove-face-A meets the inner-face at inner-edge-A, and groove-face-B meets the inner-face at inner-edge-B;

groove-face-A is formed with a set of melt-conveying-channels-A, and groove-face-B is formed with a set of melt-conveying-channels-B;

the die-member includes a melt-entry-port, which is located in the circumferential outer-face of the die-member;

the melt-conveying-channels-A include N spiral-grooves-A, which are open, and are formed into the groove-face-A;

the apparatus is so arranged that melt, in flowing towards the inner-edge-A, spills over lands between turns of the spiral-grooves-A;

the melt-conveying-channels-A are arranged for conveying liquid melt under pressure from the melt-entry-port in the outer-face, in a progressively inwards sense, through the spiral-grooves-A, to, and over, the inner-edge-A of the groove-face-A;

the melt-conveying-channels-B include M spiral-grooves-B, which are open, and are formed into the groove-face-B;

the apparatus is so arranged that melt, in flowing towards the inner-edge-B, spills over lands between turns of the spiral-grooves-B;

the melt-conveying-channels-B are arranged for conveying liquid melt under pressure from the melt-entry-port in the outer-face, in a progressively inwards sense, through the spiral-grooves-B, to, and over, the inner-edge-B of the groove-face-B;

with respect to a datum-point on the outer-face of the die-member, melt-conveying-channels-A in groove-face-A lie orientated at an orientation-angle-A thereto, and melt-conveying-channels-B in groove-face-B lie orientated at an orientation-angle-B thereto;

and the groove-face-A is staggered, circumferentially, with respect to

the groove-face-B, in that orientation-angle-A is different from orientation-angle-B.

separate indept claim to flow mixing channels, based on claiming the channels rather than the flows

Claim 22. Extrusion die apparatus, for manufacturing blown plastic film, wherein:

the apparatus includes a first-grooved-die-member;

the first-grooved-die-member is of generally annular form, and has a circumferential first-outer-face;

the first-grooved-die-member has a groove-face-A, which is of annular configuration, and which has an inner-edge-A;

the groove-face-A is formed with melt-conveying-channels-A;

the first-grooved-die-member includes a melt-entry-port;

the melt-entry-port is located in the first-outer-face;

the apparatus includes a second-die-member;

the second-die-member is formed with an annular groove-opposing-surface-A;

the melt-conveying-channels-A include a set of N spiral-grooves-A, which are open, and are formed into the groove-face-A;

the melt-conveying-channels-A include a set of N start-channels-A, the arrangement of which is such that the spiral-grooves-A are in melt-conveying-communication with respective ones of the start-channels-A;

the groove-face-A being in operative contact with the groove-opposing-surface-A, the melt-conveying-channels-A are arranged suitably for conveying liquid melt under pressure from the melt-entry-port in the first-outer-face, in a progressively inwards sense, to the inner-edge-A of the groove-face-A;

the melt-conveying-channels-A include a set of 2N feed-channels-A;

the melt-conveying-channels-A include a set of N supply-channels-A;

the arrangement of the melt-conveying-channels-A is such that liquid melt passes under pressure from the melt-entry-port inwards first to the supply-channels-A, then inwards to the feed-channels-A, then inwards to the start-channels-A, then inwards

to the spiral-grooves-A, then inwards to the inner-edge-A of the groove-face-A;

the melt-conveying-channels-A include N supply/feed-junctions-A, and N feed/start-junctions-A;

at the supply/feed-junctions-A, the supply-channels-A communicate with respective pairs of the feed-channels-A, and the arrangement of the apparatus is such that the streams of melt flowing inwards from the respective supply-channel-A divide each into two streams, one in each of the respective pair of feed-channels-A;

at the feed/start-junctions-A, the start-channels communicate with respective couples of the feed-channels-A, and the arrangement of the apparatus is such that, in respect of each one of the feed/start-junctions-A, the two streams of melt flowing inwards from the respective couple of the feed-channels-A combine together into a single stream, in the respective one of the start-channels-A.